Physical Infrastructure
(Breakout 1 of 2)

John Samuels and Charles Nemmers, *Cochairs*

This group represented diverse interests and had a significant representation from the maritime area. The group's task was to identify constituency needs and then apply a decision framework to reflect federal transportation research and development (R&D) needs. The process is as important as the product.

The current U.S. transportation infrastructure includes the following:

- 4 million miles of roads,
- 575,000 bridges,
- 240,000 miles of intercity rail,
- 11,000 miles of urban rail,
- 190,000 miles of petroleum pipelines,
- 26,000 miles of navigable waterways, and
- Airports and seaports.

As a starting point the participants reviewed the four major program objectives of physical infrastructure R&D, as set forth in the National Science and Technology Council's draft Strategic Implementation Plan.

1. Reduce backlog of infrastructure rehabilitation/renewal,
2. Improve performance of transportation physical infrastructure,
3. Provide a technical base for future transportation systems, and
4. Ensure that the physical infrastructure will perform acceptably during natural disasters.

Process

Using an affinity diagram approach, the group developed a list of physical infrastructure R&D needs, identifying 10 to 20 needs in each of the four areas. To focus on these needs, the group was divided into four subgroups. Each subgroup was charged with identifying and ranking the top half of the needs according to priority. The federal role and framework discussions from earlier in the forum provided overall decision guidance; the subgroups actually identified significant criteria used in their selections. The process was a mini customer outreach and ranking process.

Product

The four lists of federal R&D needs in order of priority follow.

1. Reduce Backlog of Infrastructure Rehabilitation/Renewal

A. *Models.* Develop models and systems that will improve the ability of governments to make physical transportation infrastructure decisions. Include the areas of life-cycle costs, accessibility concerning the Americans with Disabilities Act and pedestrians, and "smart" systems that can detect and predict failure. Place emphasis on determining what infrastructure is affordable.

B. *Materials.* Support actual construction work in all modes through the R&D of high-performance, low-cost, durable, "smart," and constructible materials.

C. *Methods.* Conduct national R&D to develop designs for using these new materials, nondisruptive or minimally disruptive construction practices, and flexible structural preassembly techniques for high-performance materials.

D. *Barrier removal.* Remove institutional barriers, which is as important as developing new models, materials, and methods. Legal, procedural, state-of-the-practice, insurance, and other issues are barriers to innovation and improvement. Conduct R&D for such areas as tort reform, procurement reform, performance-based specifications, codes, and standards.

2. Improve Performance of Transportation Physical Infrastructure

A. *Models.* Develop life-cycle costing models for transportation infrastructure elements. Develop intermodal system optimization models for freight and passengers that quantify the cost trade-offs of shifting long-haul freight from highways to alternate modes.

B. *Management.* Develop congestion management strategies for transportation of freight and passengers so that better resource allocation decisions can be made in harmony with the modes.

C. *Minimization of delays.* Develop a set of performance standards for maintenance practices aimed at minimizing delays to the user.

D. *Human factors.* Improve the part of the physical infrastructure that safely moves people and goods. Include research that supports a holistic system of people-vehicle-infrastructure—infrastructure signage displays (electronic, visual, etc.) tied to vehicle guidance and control.

3. Provide a Technology Base for Future Transportation Systems

A. *Models.* Develop system assessment and optimization for freight and passenger transportation. Integrate condition assessment technologies across modes (nondestructive evaluation, corrosion monitoring, etc.)

B. *Materials.* Conduct research, without regard for mode, on new high-performance materials and selected standards and specifications.

C. *Control systems for freight movement.* Ensure that control systems for the movement of cargo are independent of mode; that is, a package must be able to be transported from Point A to Point B, without concern for mode. Accordingly, ensure compatibility of control systems for all modes (i.e., transponders, bar codes, radio frequencies, and protocols).

D. *Tunnels.* Conduct research on economical subsurface construction technology, keeping in mind that such research is important in developing effective cargo distribution systems, especially in urban areas and for highway/rail grade separation.

E. *Harmonize.* Make design assumptions, performance criteria, and so forth consistent across all transportation modes, which will allow material specifications, tests, seismic design, geotechnical parameters, and so on to be harmonized across modes.

F. *Recycling.* Conduct research to maximize recycling potential, in all modes, of dredge material, tires, asphalt concrete and portland cement concrete pavements, and so forth.

G. *New infrastructure.* Develop a new infrastructure to accommodate new vehicles. Smaller cars and larger trucks make sharing the same lane less safe and less efficient; therefore, decide whether to construct or restripe larger truck lanes and narrower automobile lanes.

H. *Decision support.* Conduct research into the value and application of private-sector models to the public sector. The private sector, which has a profit motive, has a different system optimization and capital asset management approach than what the Intermodal Surface Transportation Efficiency Act of 1991 seems to have generated in the public sector.

4. Ensure Acceptable Performance of Physical Infrastructure During Natural Disasters

A. Conduct research on techniques for modal flow and sustainability.

B. Develop disaster prediction/forecast sensors for ice control.

C. Create methods to ensure quick resupport of damaged structures.

D. Produce emergency response and recovery strategies.

E. Formulate designs and specifications to better accommodate and control disaster forces (i.e., fused designs) to limit damage and facilitate quicker repairs.

Summary

Session participants agreed that the four major program objectives for physical infrastructure R&D acceptably set a framework for discussion, comment, and analysis; however, three of the four subgroups in this session called for national strategic assessment and modeling as a first priority. Having a national infrastructure "road map" to provide guidance for government decision making at all levels seems prudent.

Similarly, the group identified the need for model development techniques for total transportation system assessment and optimization. This would allow better R&D resource allocation, and harmonizing the designs, specifications, and so forth for new high-tech materials would lead to quicker and smoother adoption of these technologies. Modest effort in this area will result in significant gain.

Many reasons for a federal or national transportation R&D program were discussed in the breakout sessions and in other sessions during the forum. This group selected the following as the most influential characteristics of a national R&D program:

- Such a program can be national or international in scope and cross modal with emphasis on intermodal linkages.
- Such a program can lead to system efficiencies—control strategies—and can harmonize designs, specifications, and so forth to better control costs.

Physical Infrastructure
(Breakout 2 of 2)

Richard Livingston and Peter Kissinger, *Cochairs*

The session began with a brief overview of the main points of the Transportation Physical Infrastructure section of the Strategic Implementation Plan. Thirteen federal organizations have been identified as having research and development (R&D) programs relevant to transportation. Measured in terms of fiscal year 1995 budget authority, the Federal Highway Administration has the largest share, with $169 million (66 percent of the total). Next is the U.S. Army Corps of Engineers, with $31 million. Both the National Institute for Standards and Technology ($14 million) and the National Science Foundation ($15 million) have programs that, although not explicitly tied to the physical infrastructure, support basic research in applicable areas, such as concrete materials science, nondestructive testing, and robotic construction.

Four goals are set forth in the draft Strategic Implementation Plan:

1. Reduce the backlog of needed repairs,
2. Improve the performance of the existing infrastructure,
3. Plan for transition to the infrastructure of the future, and
4. Maintain emergency response capability.

To meet these goals, six R&D thrusts are proposed in the report:

1. Diagnostics, combining materials science, nondestructive testing, and computational structural mechanics;
2. High-performance materials for infrastructure renewal;
3. Automation for infrastructure renewal engineering;
4. Emergency response technology;
5. Reduction of hazards at intermodal connectors; and
6. Regional intermodal maintenance management.

There was no time to develop detailed and coordinated interagency research programs for any of these thrusts in time for the submission of the fiscal year 1996 budget. This kind of detailed planning will be a major emphasis of the Physical Infrastructure Subcommittee in the National Science and Technology Council's process for preparing the fiscal year 1997 budget submission.

Much of the group's response to the draft Strategic Implementation Plan concerned the goals that have been identified. It was pointed out that R&D by itself will not reduce the backlog of physical infrastructure needs. With sufficient funding, the backlog would be eliminated anyway, using current technology. What R&D can provide is more effective technology and methods that allow more to be done with limited funding.

Regarding the second goal, the group pointed out that improving the performance of the infrastructure was not simply a matter of making physical improvements. Other approaches, including traffic operations management and economic incentives, may be equally effective. The wording of the goals should be revised to reflect these concerns.

The group agreed with the six proposed R&D thrusts. No additional ones were proposed. Because no specific research projects have been identified for these thrusts, it was not possible for the group to develop a set of priorities. However, the group had several recommendations for the process of developing the R&D programs along these thrusts. These include scanning international R&D activities for possible technology transfer and involving stakeholder groups more frequently in planning and conducting future R&D.

Although the charge of this breakout session was to discuss the physical infrastructure, the group believed that the interrelationships with other subcommittees could not be ignored. The group recommended that a study be made of ways to overcome institutional barriers that hinder the widespread use of innovative technologies in constructing and maintaining the physical infrastructure. Standards for physical infrastructure and maintenance should be set to establish performance benchmarks for which the private sector can aim. These benchmarks should be reevaluated periodically. The standards should not constrain technological innovation.

The group also recommended that it, or a similar group, be convened periodically in the future to evaluate the progress of the physical infrastructure R&D program.